

## CALIFORNIA ENERGY COMMISSION

1516 NINTH STREET  
SACRAMENTO, CA 95814-5512  
www.energy.ca.gov

November 8, 2010

Mr. Gregory D. Skannal, HSSE Manager  
Hydrogen Energy International LLC  
One World Trade Center, Suite 1600  
Long Beach, CA 90831-1600

**RE: HYDROGEN ENERGY CALIFORNIA PROJECT (08-AFC-8)  
DATA REQUEST SET 4 (#s 219 -244)**

**DOCKET****08-AFC-8**

DATE NOV 08 2010

RECD. NOV 08 2010

Dear Mr. Skannal:

Pursuant to Title 20, California Code of Regulations, Section 1716; the California Energy Commission staff seeks the information specified in the enclosed data requests. The information requested is necessary to: 1) more fully understand the project, 2) assess whether the facility will be constructed and operated in compliance with applicable regulations, 3) assess whether the project will result in significant environmental impacts, 4) assess whether the facilities will be constructed and operated in a safe, efficient and reliable manner, and 5) assess potential mitigation measures.

This set of data requests (#s 219 -244) is being made in regards to the carbon dioxide (CO<sub>2</sub>) enhanced oil recovery (EOR) component of the Hydrogen Energy California (HECA) project. We would appreciate written responses to the enclosed data requests on or before December 8, 2010.

If you are unable to provide the specific information requested, need additional time, or object to providing requested/specific information, please send a written notice to Commissioner James D. Boyd, Vice Chair and Presiding Committee Member for the HECA project, and to me, within 20 days of receipt of this letter. If sent, this notification must contain the reason(s) for not providing the information, the need for additional time, and the grounds for any objections (see Title 20, California Code of Regulations, section 1716 (f)).

If you have any questions, please call me at (916) 654-5191 or email me at [rjones@energy.state.ca.us](mailto:rjones@energy.state.ca.us).

Sincerely,

Rod Jones  
Project Manager

Enclosure  
cc: Docket (08-AFC-8) and POS

PROOF OF SERVICE (REVISED 10/21/10 ) FILED WITH  
ORIGINAL MAILED FROM SACRAMENTO ON 11/8/10

TG

**Technical Area:** Carbon Dioxide (CO<sub>2</sub>) Enhanced Oil Recovery (EOR)  
**Author:** Tadeusz W. Patzek and Abdel-Karim Abulaban

## **BACKGROUND**

### **Carbon Capture and Sequestration**

One very important premise of this project is the ability to store (carbon capture and sequestration – CCS) the excess amounts of carbon dioxide (CO<sub>2</sub>) that would be produced by the Hydrogen Energy of California (HECA) project. The HECA project would produce approximately 2,300 lbs of CO<sub>2</sub> per gross megawatt-hour, which would be about 1,200 lbs more than permitted by the SB1368 Emission Performance Standard (EPS) for baseload power plants. Therefore, the applicant has to demonstrate that at least 1,200 lbs per megawatt-hour of CO<sub>2</sub> can be stored permanently. Additionally, the project's emissions of CO<sub>2</sub> must be analyzed in accordance with the California Environmental Quality Act (CEQA).

Occidental of Elk Hills, Incorporated (OEHI) proposes to inject the compressed CO<sub>2</sub> purchased from HECA into their Elk Hills reserve for enhanced oil recovery (EOR) and CCS. A storage rate or trapping ratio of 1:3 of CO<sub>2</sub> per pass was claimed by the applicant when injecting CO<sub>2</sub> for enhanced oil recovery (EOR) and for CCS. This trapping ratio seems unrealistic given that there is no basis from field data, especially when compared with many other documented injection projects that report an average recirculation rate of 100 percent of purchased CO<sub>2</sub> and thus a trapping ratio of zero. Staff is aware of the results of the study conducted at the University of Wyoming that indicates a trapping ratio on the order of 1:3 per pass, but cannot verify this ratio from pilot studies or reports. In 2005, OEHI conducted a 4-month, single pilot project EOR injection well in the Elk Hills Main Body of the B interval (MBB) sand with 3 producer wells, 345A-35S, 346-35S, and 356-35S, and one observation well 110 ft from the injector well. As OEHI stated in the CO<sub>2</sub> EOR project permit (sample permit) submitted to the Energy Commission in April 2010, critical information was gained during the pilot program, including confirmation of containment within the Stevens reservoir rock beneath the Reef Ridge (RR) Shale interval. This data may provide the basis for the trapping ratio and the ability of the project to comply with the EPS.

## **DATA REQUEST**

219. Please provide the OEHI reports detailing the EOR/CCS injection pilot project performance at Elk Hills, especially CO<sub>2</sub> injectivity and estimates of volumetric sweep.
220. Please provide any evidence to show the basis for the assumed trapping ratio. It would be useful if the applicant specifically provides data and analysis obtained from the CO<sub>2</sub> injection pilot project that was conducted at the Elk Hills Oil Field (Stevens reservoirs).
221. Please identify how the EOR project design would be able to address the potential for a trapping ratio below that currently estimated. Specifically, please identify the minimum trapping ratio/maximum CO<sub>2</sub> recirculation rate that will be able to be accommodated by the EOR project design to assure economic oil recovery and CO<sub>2</sub> sequestration.

## **BACKGROUND**

### **Pore Space Characteristics**

Many necessary pieces of technical data are missing from documentation submitted by the applicant in the revised application for certification and all subsequent submittals. The required data can be grouped in four categories: 1) Pore space characteristics and oil distribution, which are necessary to judge the availability and ease of pumping the carbon dioxide (CO<sub>2</sub>); 2) Information needed to characterize the rock formations that will help determine the response of the rocks to available and additional stresses; 3) Pore pressure, which is needed to assess the pressure at which the CO<sub>2</sub> would have to be at so that it can be injected into the formation; and 4) Formation stresses, which are needed to assess the behavior of any faults that may be present.

### **DATA REQUEST**

- 222. Please provide the cumulative oil produced from the EOR project area on primary in terms of percent original oil in place (%OOIP) and during the waterflood (%OOIP).
- 223. Please provide information on current average oil and water saturations in the project area.
- 224. Please provide information to support the estimate of 7.5 billion barrels as the pore space available for CO<sub>2</sub> injection.
- 225. Please provide information about the average oil saturation, or the hydrocarbon pore volume (HCPV).
- 226. Please provide information about estimated current gas saturation in the CO<sub>2</sub> project area.
- 227. The applicant mentioned producing 3.4 billion bbl of fluid, but did not mention how much of that fluid was oil, and how much was water. Please provide this information.
- 228. Please demonstrate how the measurements and calculations can be extrapolated to the reservoir for the life of the EOR and CCS project.
- 229. Please provide the following document referenced in the documents provided by the applicant: Merchant, D. (2006) Geologic Storage Options for CO<sub>2</sub> Sequestration, Elk Hills Oil Field, CO<sub>2</sub> Tertiary Evaluation. HEI (now HECA) Internal Report 56 pp.
- 230. Please provide the American Petroleum Institute gravity, viscosity and composition of the targeted crude.
- 231. Please provide experimental evidence of first contact or developed miscibility at reservoir conditions, as well as the measured maximum miscibility pressure (MMP) at Elk Hills.
- 232. Please provide information on current reservoir pressure (if only one number of 2,499 pound per square inch as in the report, then how measured and wherein the structure was it measured. If multiple numbers then also provide locations (x,y) and depths of the measurements.

233. Please provide information on the current reservoir temperature profile, again where and how measured.

## **BACKGROUND**

### **Rock Mechanics**

The applicant has not provided rock-mechanics data and Stevens reservoirs data that might justify the conclusions about the feasibility of the EOR and CCS project. Also, there are no *in-situ* stress measurements at multiple locations. Furthermore, there are hundreds of wells that penetrate the Reef Ridge (RR) Shale, but no statements were given as to their integrity and keeping their casing cement/casing tubular from being corroded/eroded away by the combination of CO<sub>2</sub> and carbonic acid.

## **DATA REQUEST**

234. Please provide the magnitude and orientation of the principal stress tensor(s) in the sand and shale, preferably at several locations, as well as a vertical profile of the measured/inferred reservoir pressure at several locations.
235. Please provide the principal *in-situ* stress and the orientations of its three components as a function of depth and position in the anticline. These measurements would consist of density logs for minimum vertical stress,  $S_v$ , minifractures, and wellbore breakouts for minimum horizontal stress,  $S_h$  and the calculations for maximum horizontal stress,  $S_H$ . The  $S_H$  can be calculated if sufficient information is provided.
236. Please provide the estimates of the bulk rock moduli, Poisson's ratios, and/or Young's moduli for the Stevens reservoir sandstone and the confining Reef Ridge Shale.
237. Please provide information on the wells that penetrate the Reef Ridge Shale (well casing materials, well seals, annular space materials and method of construction). This information is necessary to assess the integrity of the wells and their annular spaces.
238. Please provide an analysis of the potential effects of corrosion due to CCS on well casings and annular seals for all wells in the project area.
239. Please demonstrate how the measurements and calculations can be extrapolated to the reservoir for the life of OEHI's CO<sub>2</sub> EOR project.

## **BACKGROUND**

### **Plunging Anticline**

The Oxy Hills Oil Field is characterized as a plunging anticline that forms a natural geologic trap for petroleum hydrocarbons. This anticline has formed as a result of faulting and folding of sedimentary rock in active tectonic region of California. Staff is concerned that the faulting and folding remain active and that there is potential for future rupture of existing or new faults in or along the plunging anticline which would allow for leakage and failure of the CCS component of the project.

## DATA REQUESTS

- 240. Please provide a map and figures showing the location of active and potentially active faults and time and magnitude of rupture along faults within 50 miles of the project site.
- 241. Please provide an analysis of the tectonic framework of the anticline and how it fits within the regional tectonic framework proximal to the San Andreas Fault.
- 242. Please discuss whether other CCS sites that have been tested have been located in active tectonic environments similar to the proposed CO<sub>2</sub> EOR project site.
- 243. Please discuss the potential for fault rupture in or near the anticline and leakage of CO<sub>2</sub> from the storage area during the life of CCS from OEHI's CO<sub>2</sub> EOR project.
- 244. Please discuss the pressures that would be necessary to cause seismic activity and/or fault rupture that could result in failure of the CCS. Please discuss how the project would be designed to stay below the pressures or mitigate conditions that could result in failure of the CCS due to faulting or other geologic fracturing.



**BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT  
COMMISSION OF THE STATE OF CALIFORNIA  
1516 NINTH STREET, SACRAMENTO, CA 95814  
1-800-822-6228 – WWW.ENERGY.CA.GOV**

**APPLICATION FOR CERTIFICATION  
FOR THE *HYDROGEN ENERGY*  
*CALIFORNIA, LLC PROJECT***

Docket No. 08-AFC-8

**PROOF OF SERVICE LIST**  
Rev. 10/21/10

**APPLICANT**

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### DECLARATION OF SERVICE

I, Teraja` Golston, declare that on November 08, 2010, I served and filed copies of the attached, dated (08-AFC-8) HECA – Data Request Set 4 (219-244), 2010. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: [\[http://www.energy.ca.gov/sitingcases/hydrogen\\_energy\]](http://www.energy.ca.gov/sitingcases/hydrogen_energy).

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

*(Check all that Apply)*

#### FOR SERVICE TO ALL OTHER PARTIES:

- ☒ sent electronically to all email addresses on the Proof of Service list;
- ☒ by personal delivery;
- ☐ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

**AND**

#### FOR FILING WITH THE ENERGY COMMISSION:

- ☒ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (*preferred method*);

**OR**

- ☐ depositing in the mail an original and 12 paper copies, as follows:

#### **CALIFORNIA ENERGY COMMISSION**

Attn: Docket No. 08-AFC-8  
1516 Ninth Street, MS-4  
Sacramento, CA 95814-5512  
[docket@energy.state.ca.us](mailto:docket@energy.state.ca.us)

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

\_\_\_\_\_  
Original Signature in Dockets  
Teraja` Golston